Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 1, 2019					

SPE205 – Biomechanics 1	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

Section A contains 40 multiple choice questions which are to be answered in the multiple choice answer sheet. Totalling 40 marks.
Section B contains seven (7) short answer questions which are to be answered in the answer booklet. Totalling 70 marks
Section C contains one (1) long answer question that should be answered in the answer booklet. Totalling 70 marks

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
None	1 x 20 Page Book 1 x Scrap Paper 1 x Formula Sheet 1 x Winter's Table

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Section A

Multiple Choice Questions

Total No of Marks for this section: 40

This section should be answered on the Answer Sheet provided. Please ensure that your name and student number have been written on the Answer sheet and place in the completed answer Booklet.

Marks for each question are indicated. Suggested Time allocation for Section A: 40 mins

Section B

Short Answer Questions

Total No of Marks for this section: 70

This section should be answered in the Answer Booklet provided.

All seven questions are made up of more than one component.

Answer all components

Marks for each question are indicated. Suggested Time allocation for Section B: 70 mins

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Question 41

True or False

1) Cost benefit analysis only applies to money associated with buying and installing equipment.
2) 114.6° is 2 radians.
3) According to Winter's Table, a forearm and hand is 2.2% of a person's total body weight.
4) Surface area is a contributor to the magnitude of friction.
5) Clockwise rotational motion is positive.
6) Moore's Law explains the principle that technology doubles in capacity every 12 months.
7) The central difference method measures the area under the curve.
8) A foot going into plantarflexion is an example of a 2nd class lever.
9) A force of 245 N applied to a moment arm that is 332 mm in length results in 81.34 Nm of torque.
10) A free body diagram is used to identify all external forces acting on a system of interest.

Total marks: 10

Question 42

There are three stages after a ball is dropped and let bounce on the floor: The fall; the impact; and the bounce. Each can be considered for assessment. Relative to Newton's Laws of Motion please describe:

1. How Newton's First law applies to the ball **during**, and **after** impact

(Marks: 4)

2. How Newton's Second law applies to the ball **as it is** falling

(Marks: 3)

3. How Newton's Third law applies to the ball **during** impact

(Marks: 3)

Total marks: 10

Question 43

When a ball hits the ground at an angle in a bounce, it is known as an oblique impact. Relying on your knowledge of oblique impacts, describe what occurs. In your discussion, please include topics such as:

a) The differences that no spin, top spin, and back spin can have on the ball, including (but not limited to) any effects on vertical or horizontal velocities.

b) Also include what different effects surfaces may have on the ball.

c) Include the difference in the terms "angle of incidence", "angle of reflection", "angle of approach", "angle of rebound".

Total marks: 10

Question 44

A: What is the reasoning for dimples to be on a golf ball? What difference might a ball of similar dimensions but a smooth surface have? **Justify your answer using biomechanical knowledge.** Diagrams can be used to help explain your reasoning.

(Marks: 3)

B: A primary goal of a sprint swimmer is to achieve maximum velocity. List four (4) strategies that a swimmer might apply for reducing drag, therefore increasing velocity. **Justify your answer using biomechanical knowledge.**

(Marks: 4)

C: A cyclist is riding with a tail wind of 6.8 meters per second (m/s). Their velocity is 41.2 km/h. What is the velocity of the cyclist, relative to the wind? Provide your answer in m/s.

(Marks: 3)

Total marks: 10

Question 45

A: An object about to roll off a table has 100% _____ energy and 0% _____ energy.

(Marks: 2)

B: A _____ class lever is the most common lever system in the human body.

(Marks: 1)

C: π is equal to _____ radians

(Marks: 1)

D: In theory an object that bounces as high as the point that is it dropped from has a coefficient of restitution of _____.

(Marks: 1)

E: Kinetics describes _____, kinematicsis describes _____, and _____ is the formula that ties the two concepts together.

(Marks: 3)

F: In the diagram below (Figure 2): F1 is an example of _____ motion and F2 is an example of _____ motion.

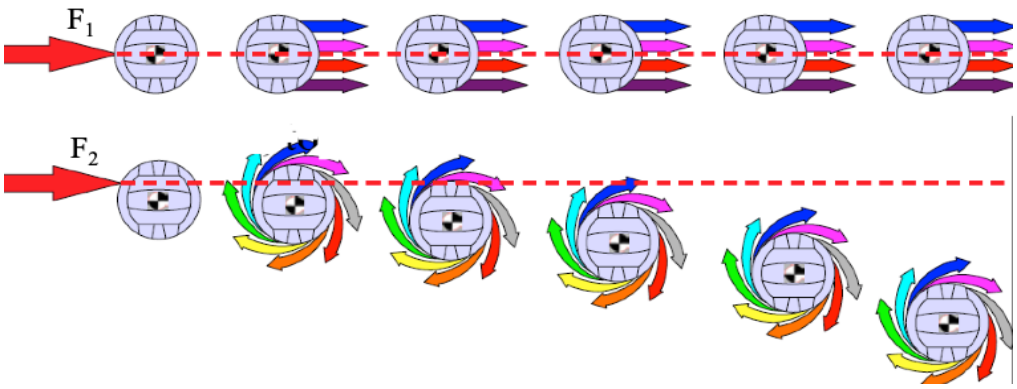

Figure 2. Two balls with forces applied at two different points.

(Marks: 2)

Total marks: 10

Question 46

A sled with a mass of 5.5 kg and its μ is 0.43 is placed on a 21° slope.

- What is the weight force of the sled?

- What is the normal force of the sled?

- What is the frictional force?

- What is the propulsive force?

- From these results, will the sled remain stationary, or will it slide?

The use of a free body diagram should be used. Show all workings and equations.

Total marks: 10

Question 47

A: Sketch a trajectory of a ball that has been thrown. Assume there is no wind at the time. Include in the Sketch vector arrows that depict vertical and horizontal velocity

(Marks: 3)

B: In another sketch of the same throw, include vector arrows depicting acceleration acting on the ball.

(Marks: 3)

C: In the annual grudge match between Hawthorn and Sydney and after a ball turnover, Buddy Franklin does one of his great runs down the left wing. Right on the 50 m arc, he kicks for goal. If the flight time is 2.72 seconds and the ball's horizontal velocity is 20.88 m/s. Assuming that he kicks accurately and including the fact that all the had moved up the field before the turnover, therefore no one guarding the goal, will the ball sail through, or fall short? Show all workings including the equation.

(Marks: 4)

Total marks: 10

This is the end of Section B. Total 70 marks

Please ensure that you have written your **name** and **student number** on your **answer booklet**.

Section C

Short Essay Question

Total Number of Marks for this section: 70

This section should be answered in the Answer Booklet provided.

There is a single question made up of concepts to discuss and equations to calculate.

Marks for each question are indicated. Suggested Time allocation for Section C: 70 mins

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Question 48

Ronald Runner wishes to know how far he can run in 10 seconds (s). He has approached you to perform an analysis of the 10 s running trial. Use Newton's 3 Laws of Motion and its effects on human movement as a basis to provide Ronald with a summary of the scientific concepts to help him better understand his running capabilities.

Figure 3. The starting position and take off of Ronald's 10 s running trial.

Part A: Kinetics

In your discussion, include the following concepts in relation to Newton's 3 Laws:

i. Friction;
ii. The kinetic chain principle;
iii. Use the previous information above as the definition, refer to Figure 3, and include a system of interest (SoI). Create two free body diagrams (FBD) one for the image on the left and one for the right;
iv. Discuss the lever system of the forces generated by the rectus femoris muscles acting on the knees during the initial push off;

(Marks: 20)

Part B: Kinematics

Ronald can be seen in the starting position of a sprint (Figure 3, left image) with the starting line southeast of the finish. The right image is just after take off.

i. Discuss his stability in the starting position.
ii. Compare it to his stability just after leaving the blocks (Figure 3, right image) and before his foot strikes the ground on the first step;
iii. Explain linear motion from angular kinematics;
iv. Detail the importance of the arms as counterbalances for running performance.

(Marks:20)

PART C: Calculations

a. Relative to the Winter's Table:
   i. If the Ronald weighs 72 kg, what is the combined mass of his upper arms?
   ii. If the right femur is 416 mm and the right shank is 398 mm, what is the distance from his right hip to the centre of mass (CoM) of his right leg?

b. Displacement, velocity, and acceleration calculations. Consider the data sets below (Figure 4 and Table 1):

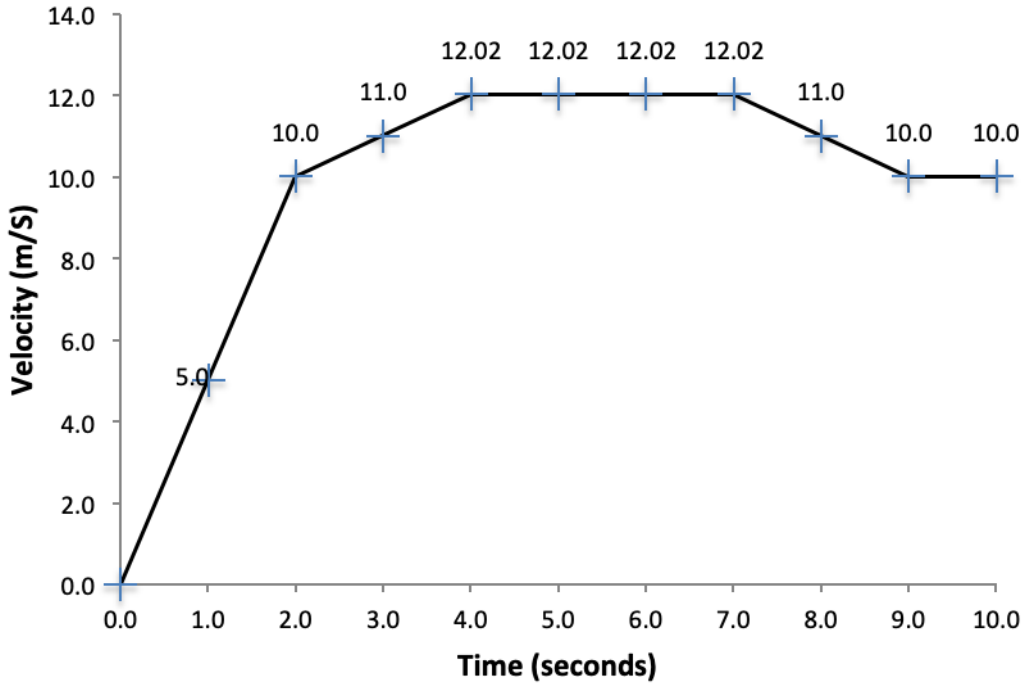

Figure 4. Velocity profile of Ronald Runner's 10 second run. The velocity values on the profile were collected at one second intervals.

Table 1. One second splits for Ronald Runner's sprint for 10 seconds.

Time (seconds)	Velocity (m/s)
0.0	0.0
1.0	5.0
2.0	10.0
3.0	11.0
4.0	12.02
5.0	12.02
6.0	12.02
7.0	12.02
8.0	11.0
9.0	10.0
10.0	10.0

i. In the 10 s run, displayed in the Figure 4 plot, what was the displacement covered by the Ronald?
ii. What was his average velocity for the whole distance?
iii. Using Ronald's outcomes of his 10 s time trial, how long would it take Ronald to complete a 100 m event?
iv. What was his instantaneous acceleration at the 3 s mark?

(Marks: 30)

Total marks: 70

This is the end of Section C. Total 70 marks

Please ensure that you have written your **name** and **student number** on your **answer booklet**.